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Caltrans Division of Research,
Innovation and System Information

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Project Title:
Measuring and Modeling Particulate
Matter Emissions from Heavy-Duty
Construction Equipment

Task Number: 1204
Completion Date: June 30, 2012

This project developed a model to
measure particulate matter emissions
from heavy equipment to address
the environmental impact of Caltrans'
construction activities and meet
regulatory requirements.

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Measuring the Particulate Matter Emissions of Construction Equipment

Developing a model for gathering emissions data to address regulatory air requirements

WHAT WAS THE NEED?

The gaseous and particulate matter emissions from construction engines are
an important portion of total air pollutants, and they are drawing increasing
regulatory attention. To assess the contribution of construction equipment,
such as that used by Caltrans for projects in non-attainment or maintenance
areas, it is necessary to quantify the nitrogen oxide and particulate matter
emissions. Currently, no model for estimating construction emissions or the
development of appropriate regulations has been mutually accepted by
Caltrans and regulatory agencies. This situation is due in part to a lack of
emissions data from construction equipment while it is in use. The results of
this research will provide scientific-based validation of emissions regarding
the environmental impact of Caltrans' construction activities, thereby reducing
project costs, improving air quality, and promoting public health.

WHAT WAS OUR GOAL?

The goal of this research was to obtain quantitative particulate matter data
on heavy-duty construction equipment and develop a model to estimate
gaseous and particulate matter emissions to address environmental
regulatory concerns.

Measuring the emissions of a backhoe

Caltrans improves mobility across California by performing applied research, developing innovations, and implementing solutions.

WHAT DID WE DO?

The focus of this task was on particulate matter emissions for which there are no commercially available instruments for use in the field. Caltrans, in partnership with the UC Riverside Center for Environmental Research and Technology (CE-CERT), took emissions measurements for seven in-use pieces of construction equipment. The equipment included four backhoes and three wheel loaders. Over the course of the test program, two different analyzers were used to gather emissions data. One analyzer measured all gaseous species, and the other measured the particulate matter. In-field emissions measurements were made on a second-by-second basis using a portable emissions measurement system to develop relationships between nitrogen oxides, particulate matter, and other emissions and fuel use. This program used instrumentation that is being developed at UC Riverside and expanded it to include particulate matter emissions.

WHAT WAS THE OUTCOME?

Most construction equipment of approximately the same size exhibited similar emission profiles. Differences between cold-start and warm-start idle emissions among the different equipment were observed. Normalizing emission output by fuel resulted in relatively small variations in emission levels under different levels of load. When the data collection effort was nearing completion, it was determined that a second phase task was needed to develop an Excel-based air emissions model to analyze collected emissions datasets. The task would focus primarily on particulate matter emissions because this evaluation gap needs to be closed.

WHAT IS THE BENEFIT?

As emissions and activity data become available for other equipment types, the emissions model can be modified so that it can have wide applicability and provide a formal basis for regulatory development. A more efficient regulatory process will allow more rapid adoption of regulations that will improve air quality and promote public health, while reducing legal costs and project delays. The emissions data gathered through this effort will be used to develop a model to determine emissions from different types of construction equipment or for construction projects as a whole. The model will be a user-friendly program based in Excel that can be readily used by program staff at Caltrans, outside contractors, or other government agencies.

LEARN MORE

To view the full report:
www.dot.ca.gov/research/researchreports/reports/2012/2012-01_task_1204_ppsi.pdf

Measuring the emissions of a wheel loader at a quarry in Thermal, California

The UC Riverside mobile emissions laboratory (MEL) is a unique laboratory containing all the instrumentation normally found in a conventional vehicle emissions laboratory but mounted inside a 53-foot truck trailer.